SuperNatural Sciences 102 Lecture 2

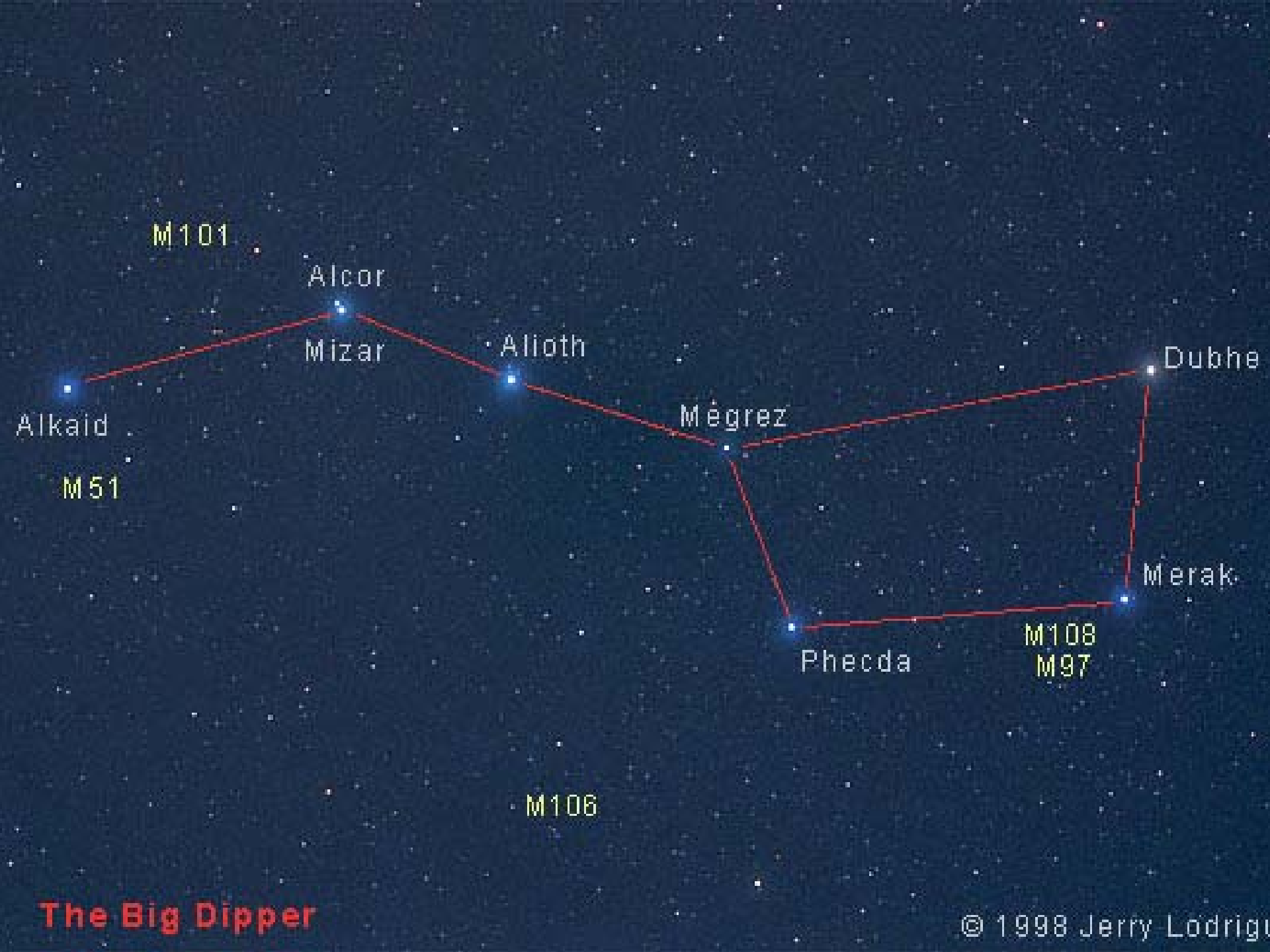
Opening song: Starry Configurations (Jets to Brazil)

FIRST MOON

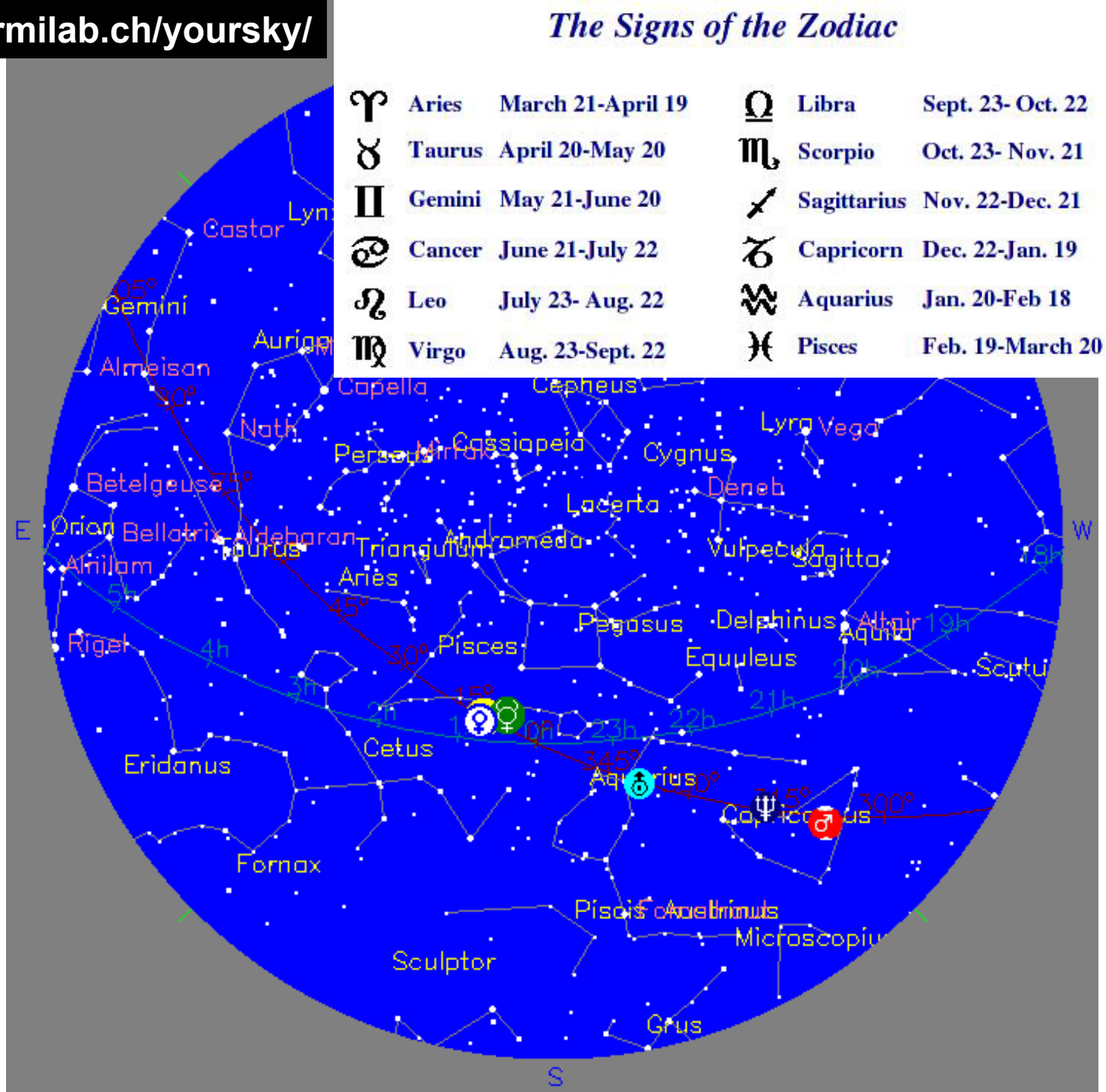
Closing song: Life on Mars (David Bowie)

Sun	moves
Moon	moves & phases
Planets	move
Stars	move
Eclipses	
Clouds	
Birds	
Rainbows	
Comets, meteors, etc	

Motion of planets different than motion of stars
Planet = wanderer


M101
Alcor
Mizar
Alioth
Dubhe
Alkaid
Megrez
M51
Merak
M108
M97
Phecda
M106
The Big Dipper
© 1998 Jerry Lodrigu

www.fourmilab.ch/yoursky/



31 March, 2005 15:00 UTC

41°52′27″N 87°38′21″W

North
East
West
South

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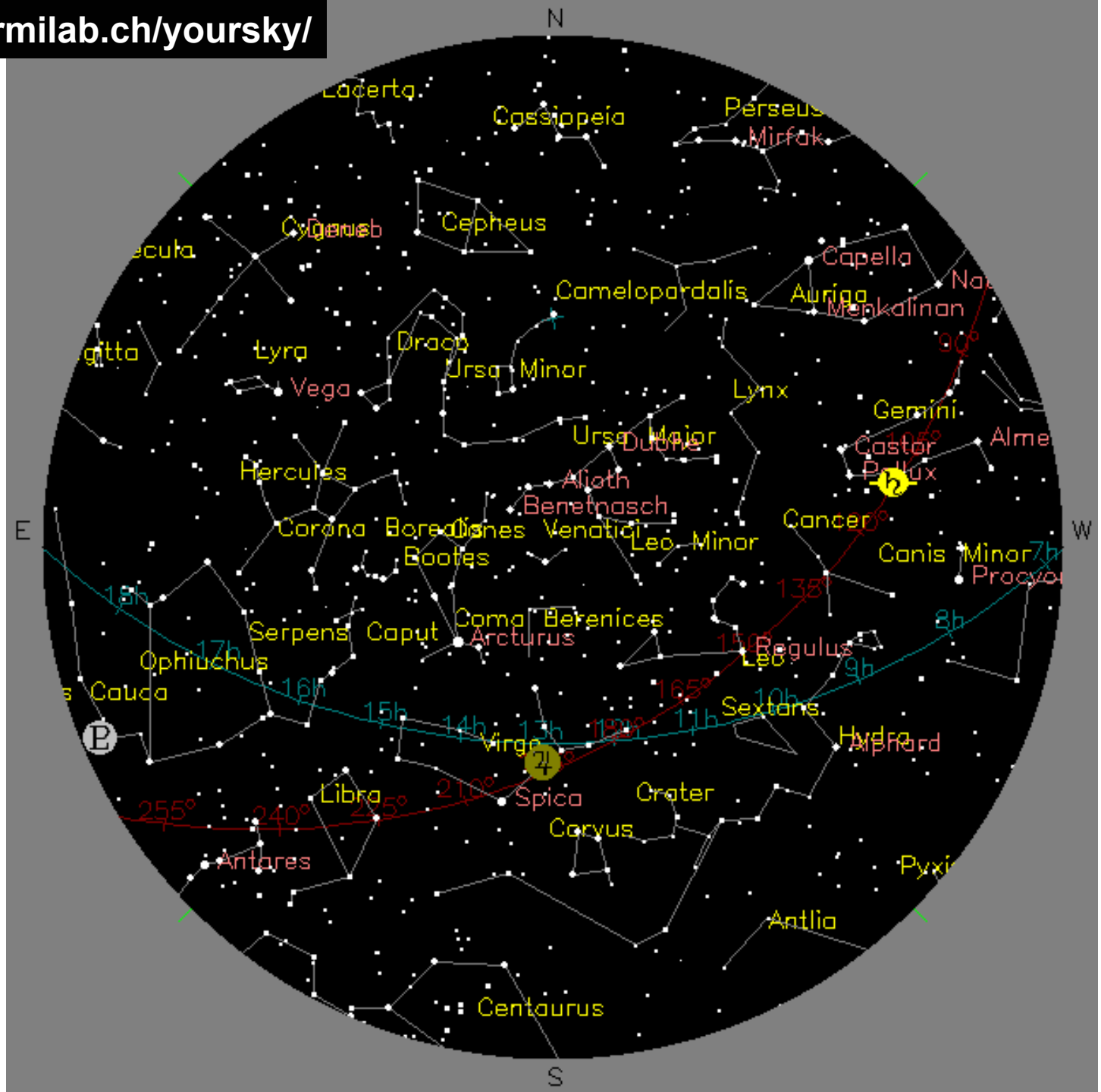

- Sun
- Mercury
- Venus
- Earth
- Mars
- Jupiter
- Saturn
- Uranus
- Neptune

1 April, 2005 06:00 UTC

41°52′27″N 87°38′21″W

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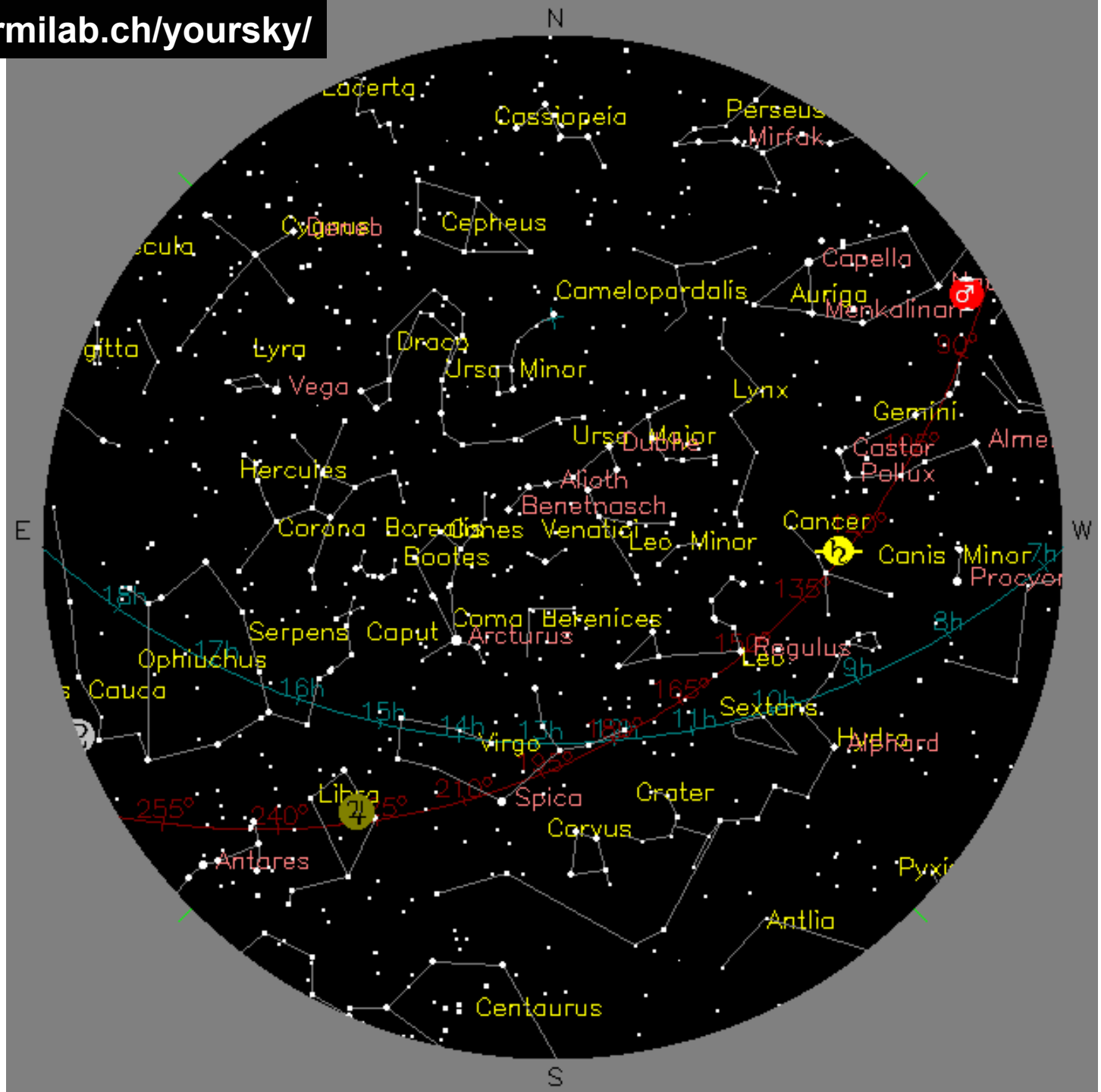

- Sun
- Mercury
- Venus
- Earth
- Mars
- Jupiter
- Saturn
- Uranus
- Neptune

1 April, 2006 06:00 UTC

41°52′27″N 87°38′21″W

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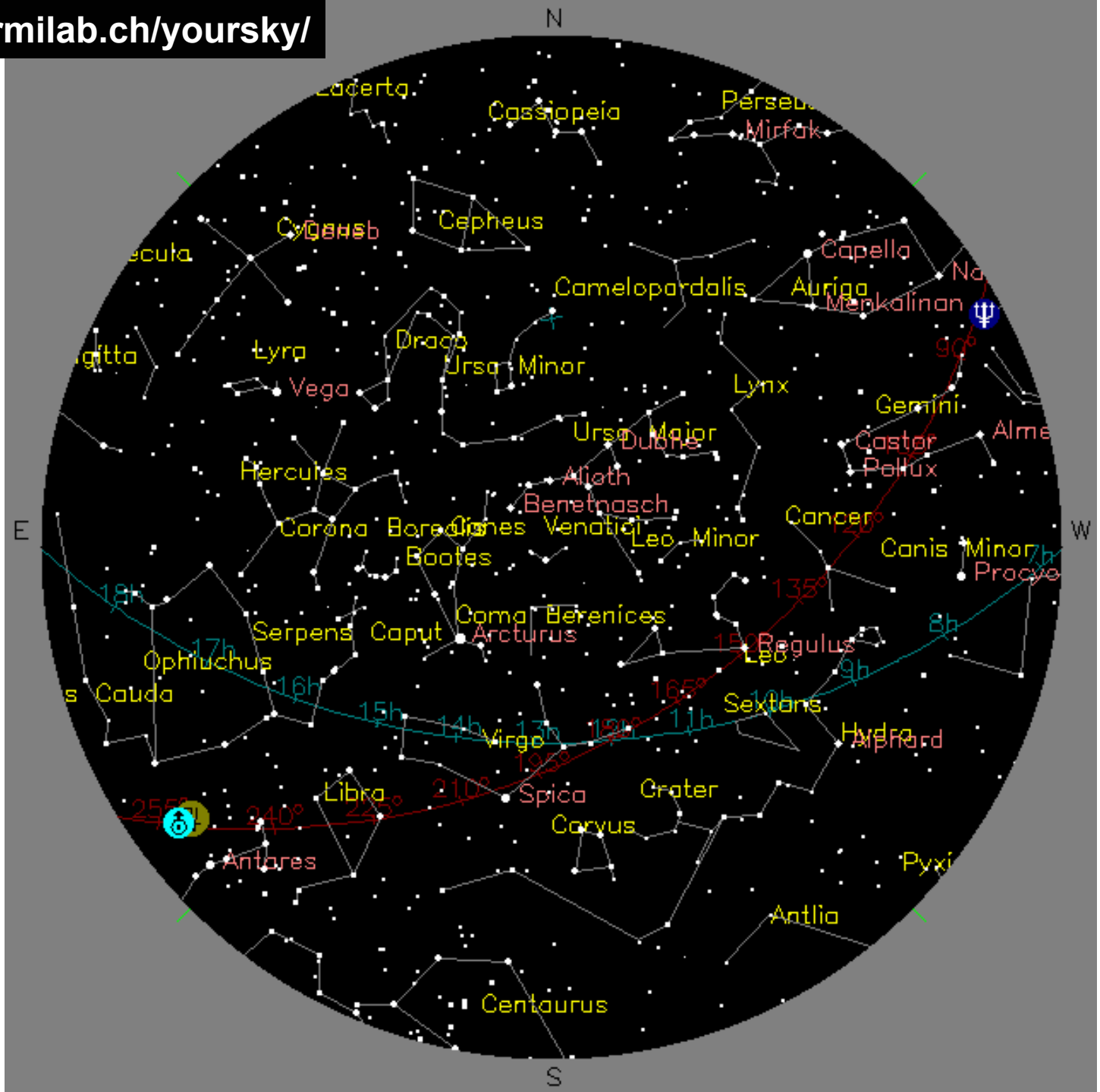
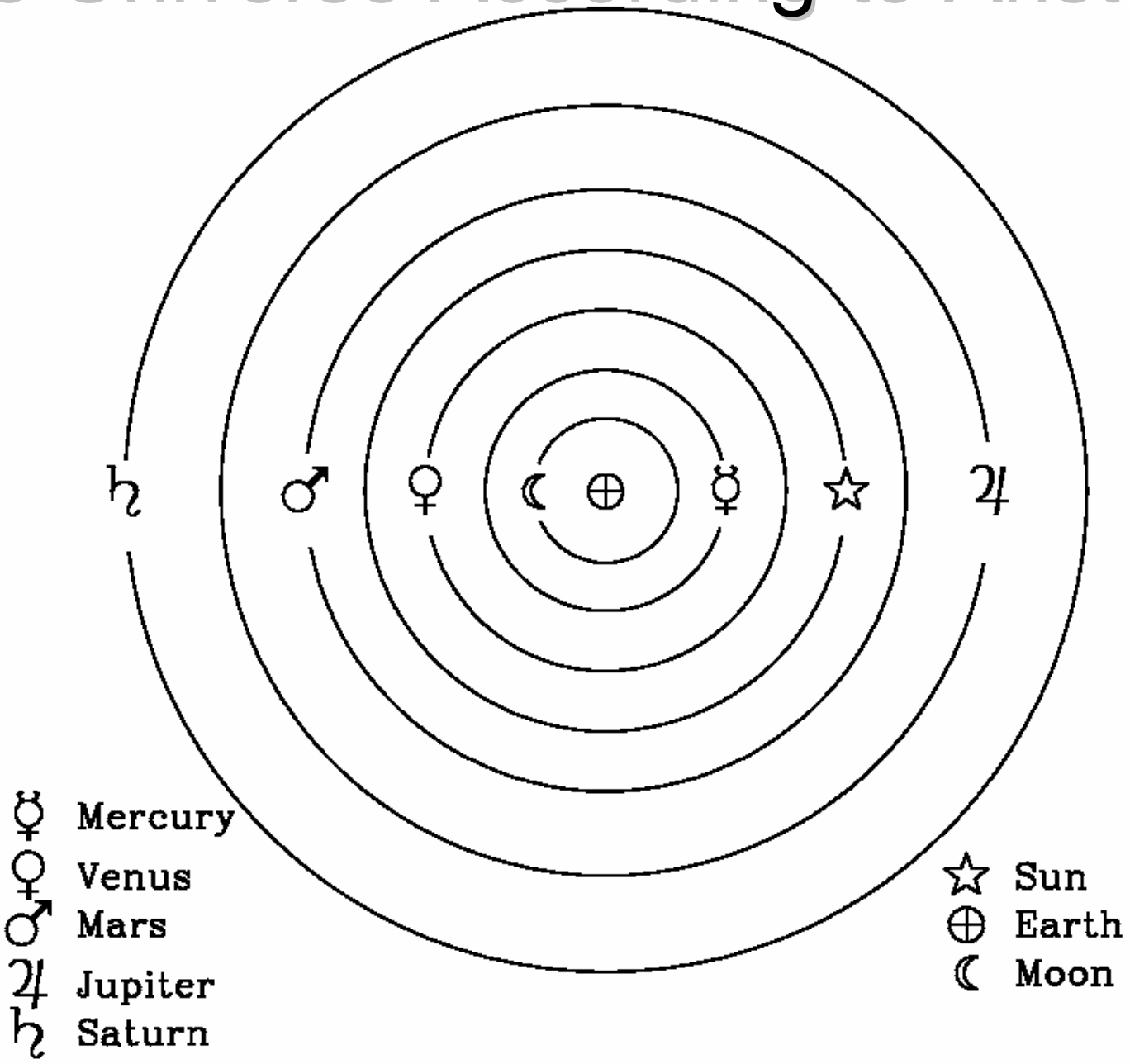


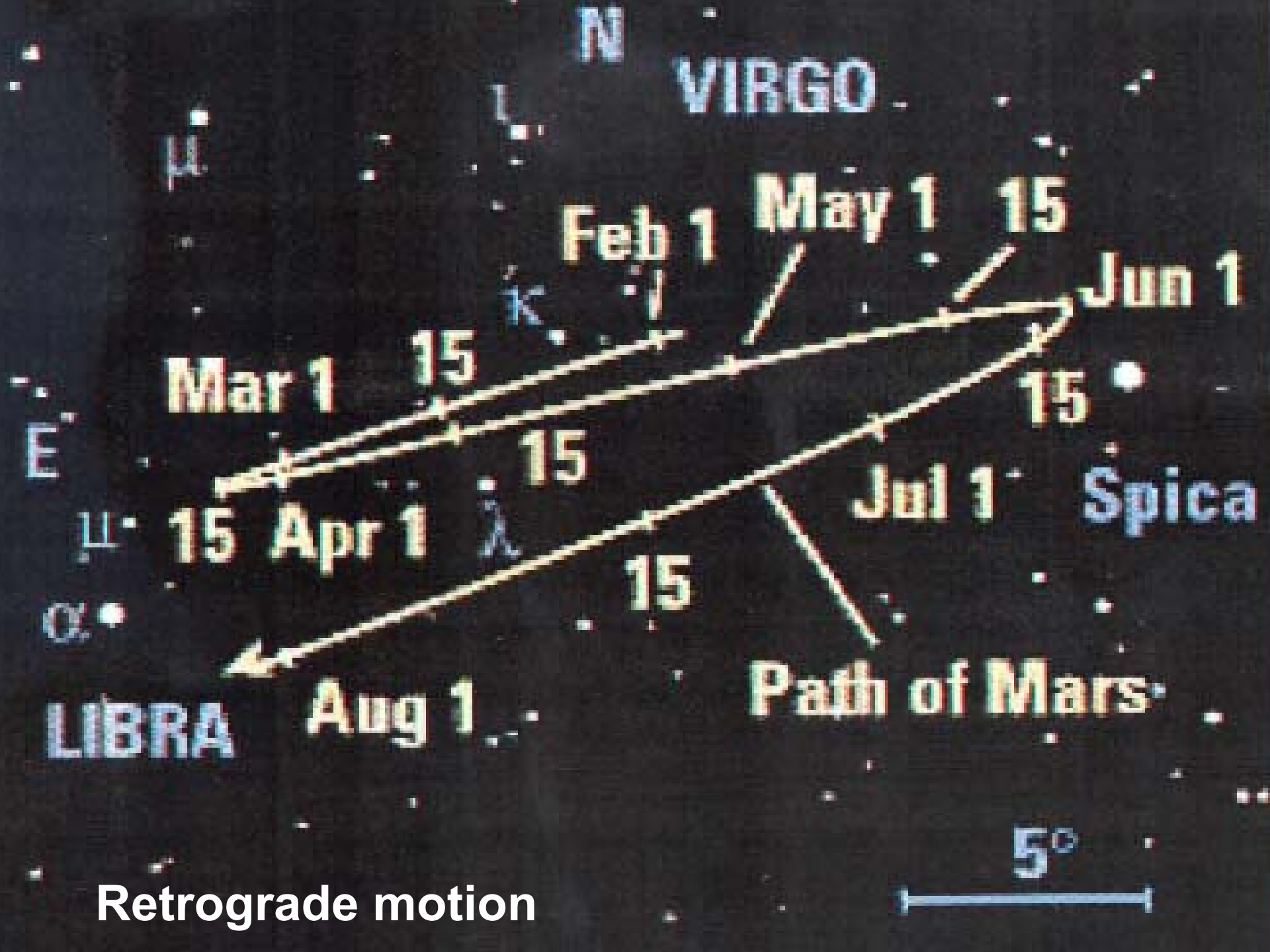
Sun
Mercury
Venus
Earth
Mars
Jupiter
Saturn
Uranus
Neptune

1 April, 1900 06:00 UTC

41°52′27″N 87°38′21″W

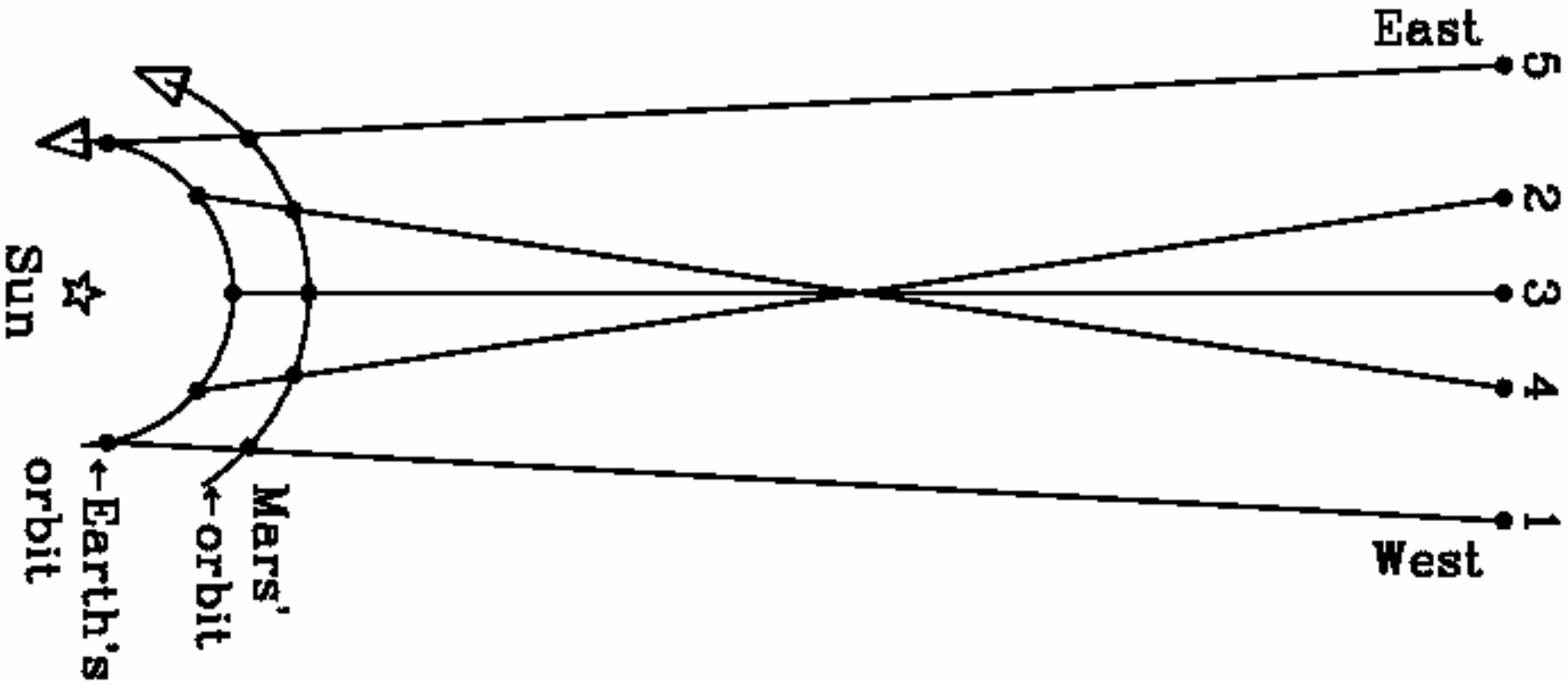
The Universe According to Aristotle



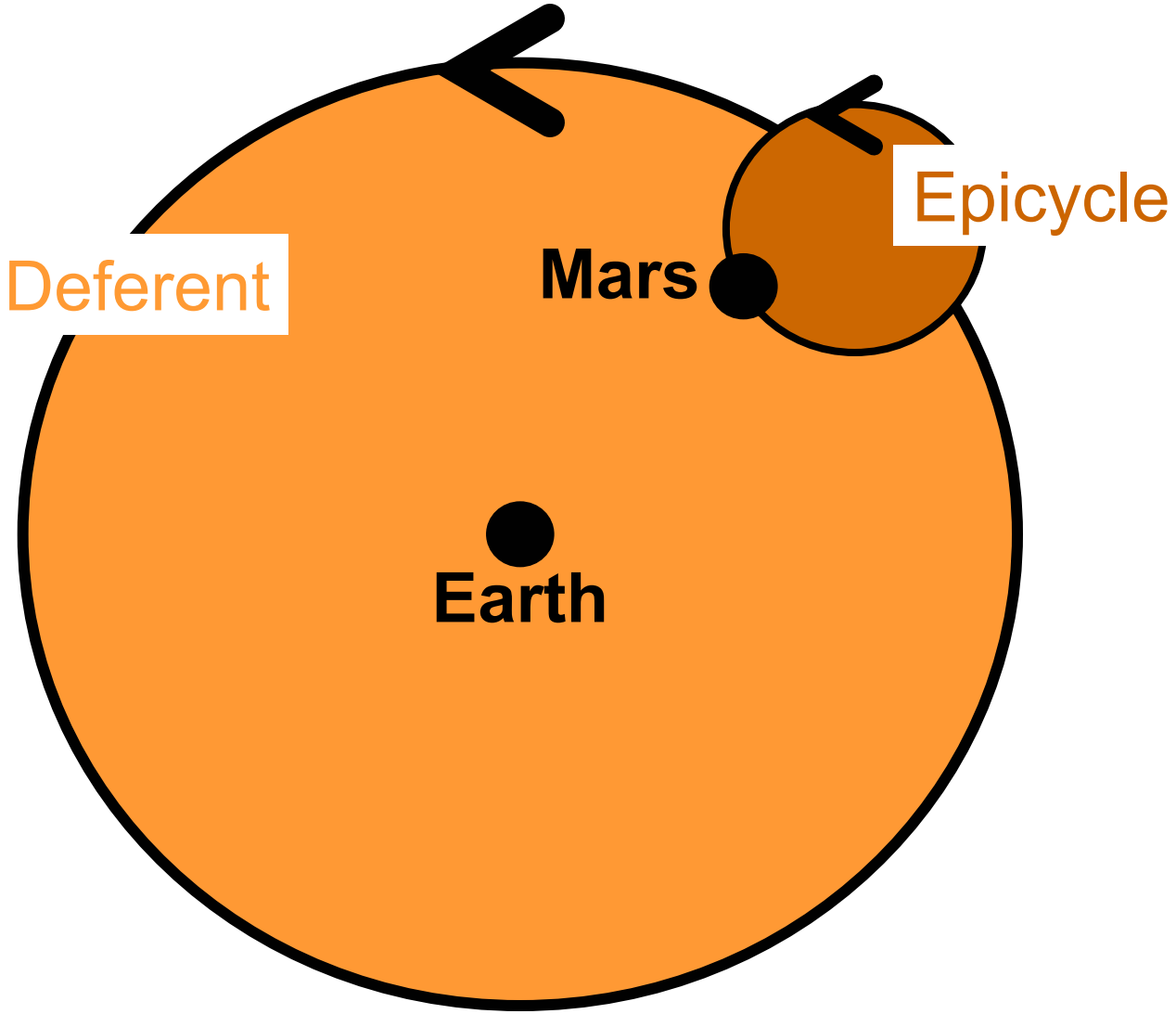


Retrograde motion

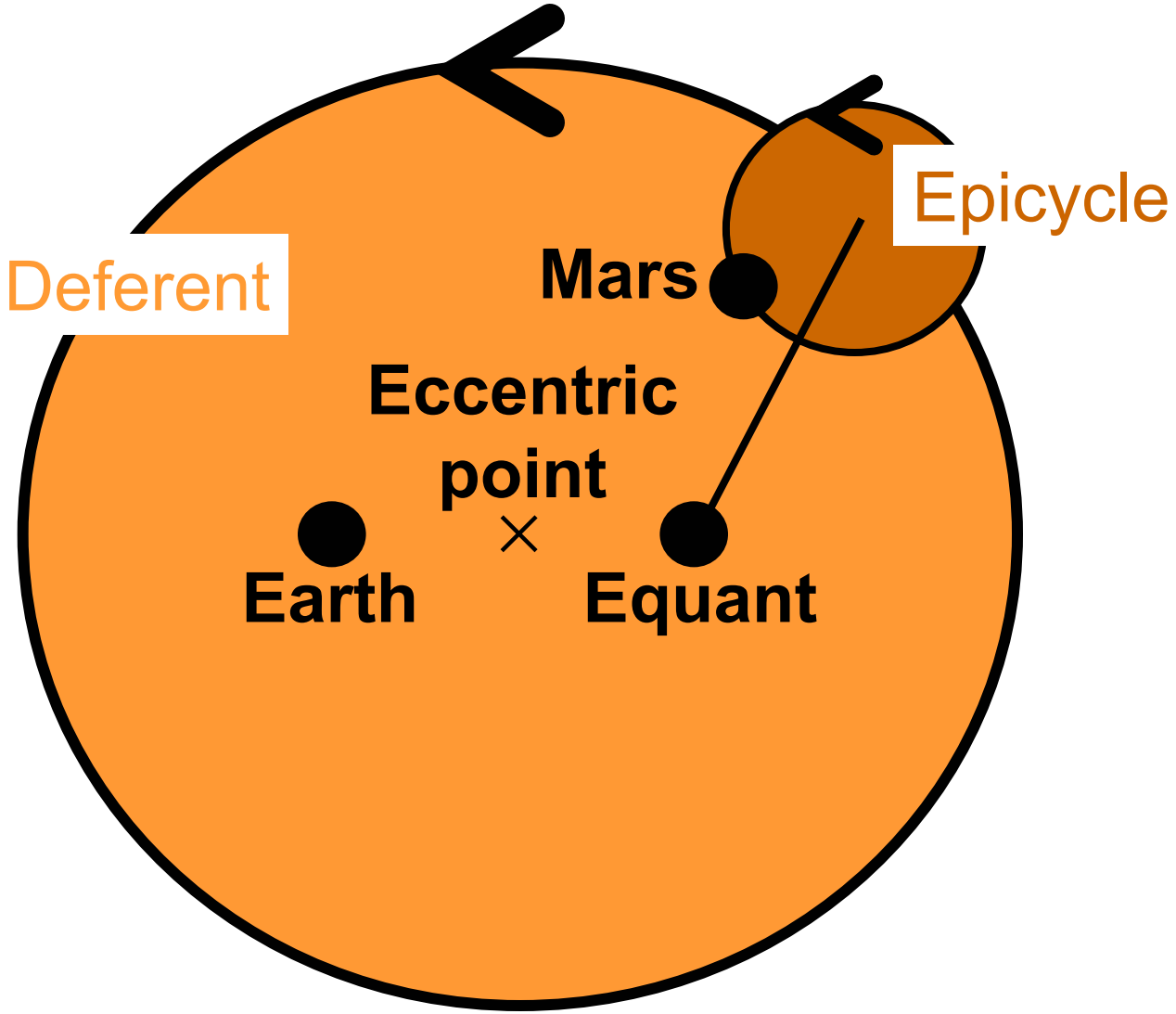
Retrograde Motion



The Ptolemaic Epicycle



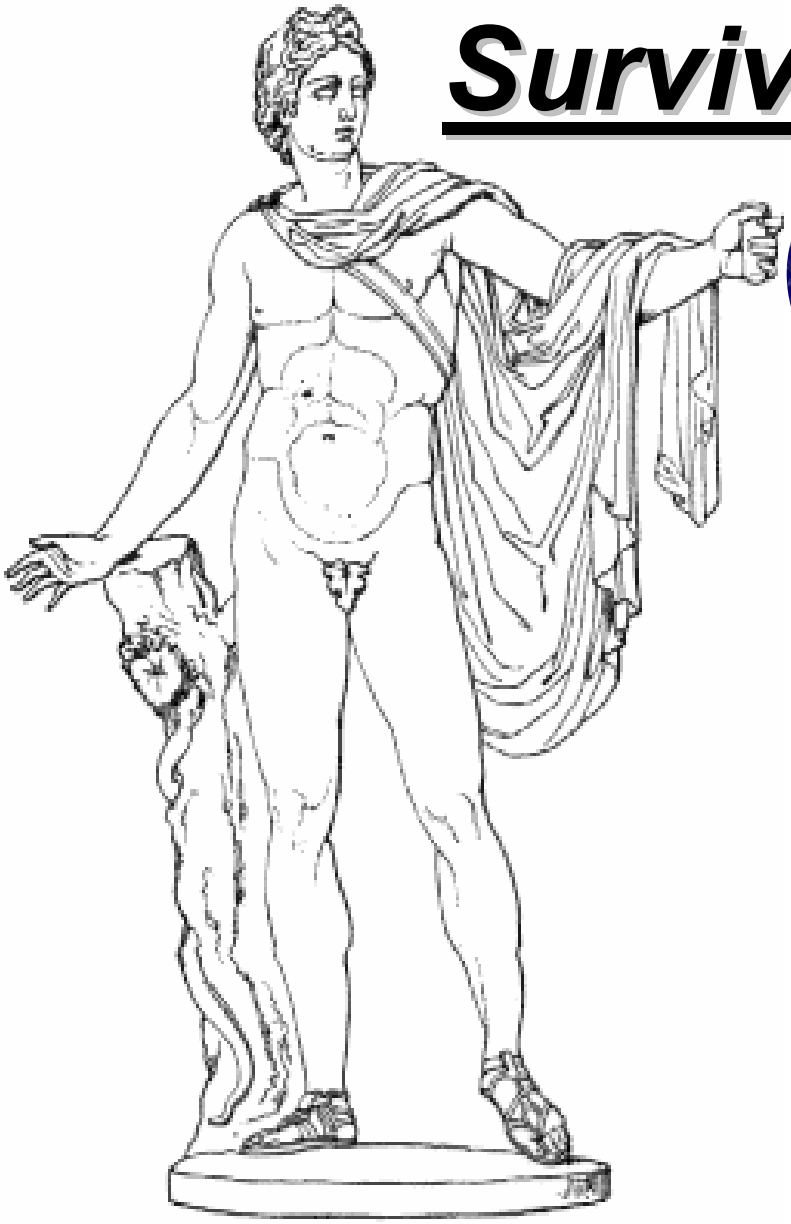
The Ptolemaic Epicycle

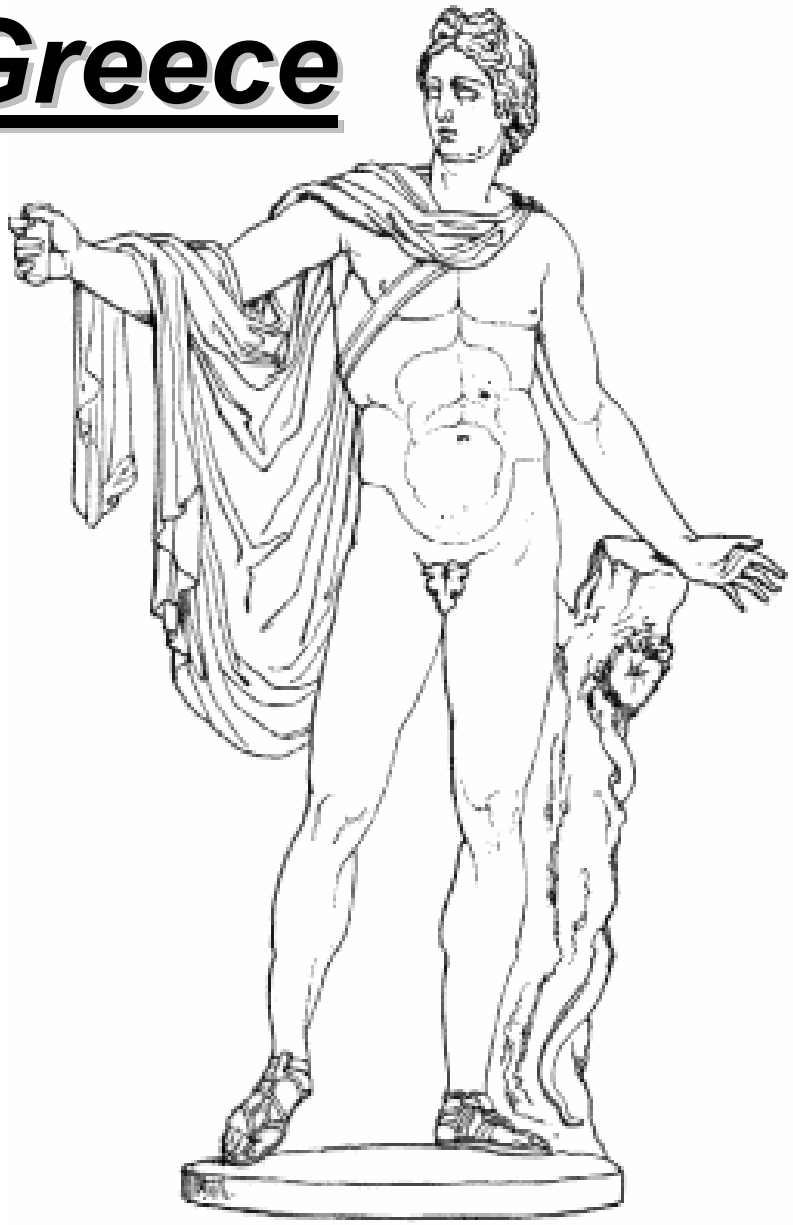


The Ptolemaic Universe

Aristotle	(ca. 350 BCE) – groundwork of "natural philosophy" basis for geocentric model (earth stationary).
Aristarchus	(ca. 270 BCE) – proposed heliocentric model and stressed that motions are circular (Earth moves).
Hipparchus	(ca. 130 BCE) – Influenced Ptolemy. Many reasonable arguments against motion of Earth. Introduced epicycles for motion of Moon.
Ptolemy	(ca. 130 CE) – Greek astronomer lived in Alexandria. Astronomer, mathematician, cartographer. Books include *Almegest* & *Planetary Hypothesis*

Survivor, Greece



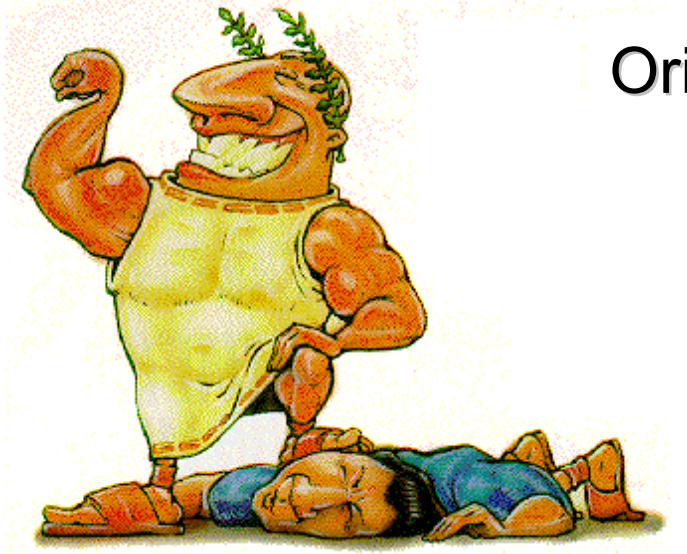


Aristotle (350 BC)
(Earth stationary)

Aristarchus (270 BC)
(Earth moves)

Survivor, Greece

A
Rocky Kolb–GnatSigh
Production



Original play (2002)
Eduardo Rozo
Tim Donaghy
Jim Chisholm

Adapted (2004)
Rocky Kolb

Featuring the "Not Ready for Class Time Players:"

Aristotle Jones:	Andrew Hill
Aristarchus Johnson:	Alberto Vallinotto
Ptolemy Thompson:	Tim Donaghy
Chorus:	Felipe Marin
	Erwin Lau
	Carlos Cunha
Lighting & Music:	Kurt Henrikson
Best Boy:	Don M. Randel
Key Grip:	Richard Saller

Neither animals nor graduate students were harmed in this production!

Rocky Kolb-GnatSigh
Productions
Presents

The Dialogue C
Two Chi

, 2004

UNRATED!!!!!!
contains cosmologically explicit material

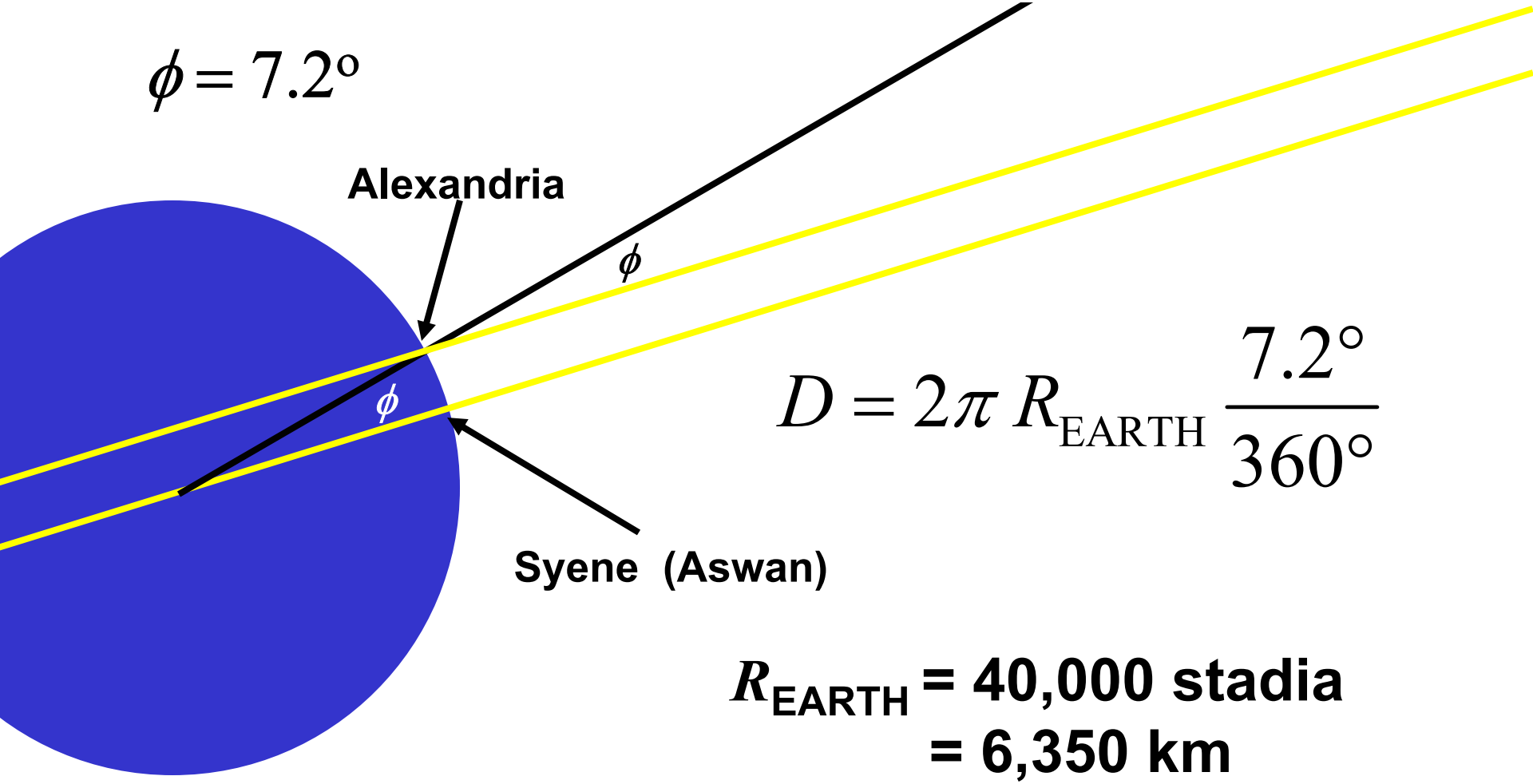
Need three thespians

Size does matter

Size of Earth (Erathosthenes ~ 250 BC)

D = distance between Syene & Alexandria = 5000 stadia

$$\phi = 7.2^{\circ}$$

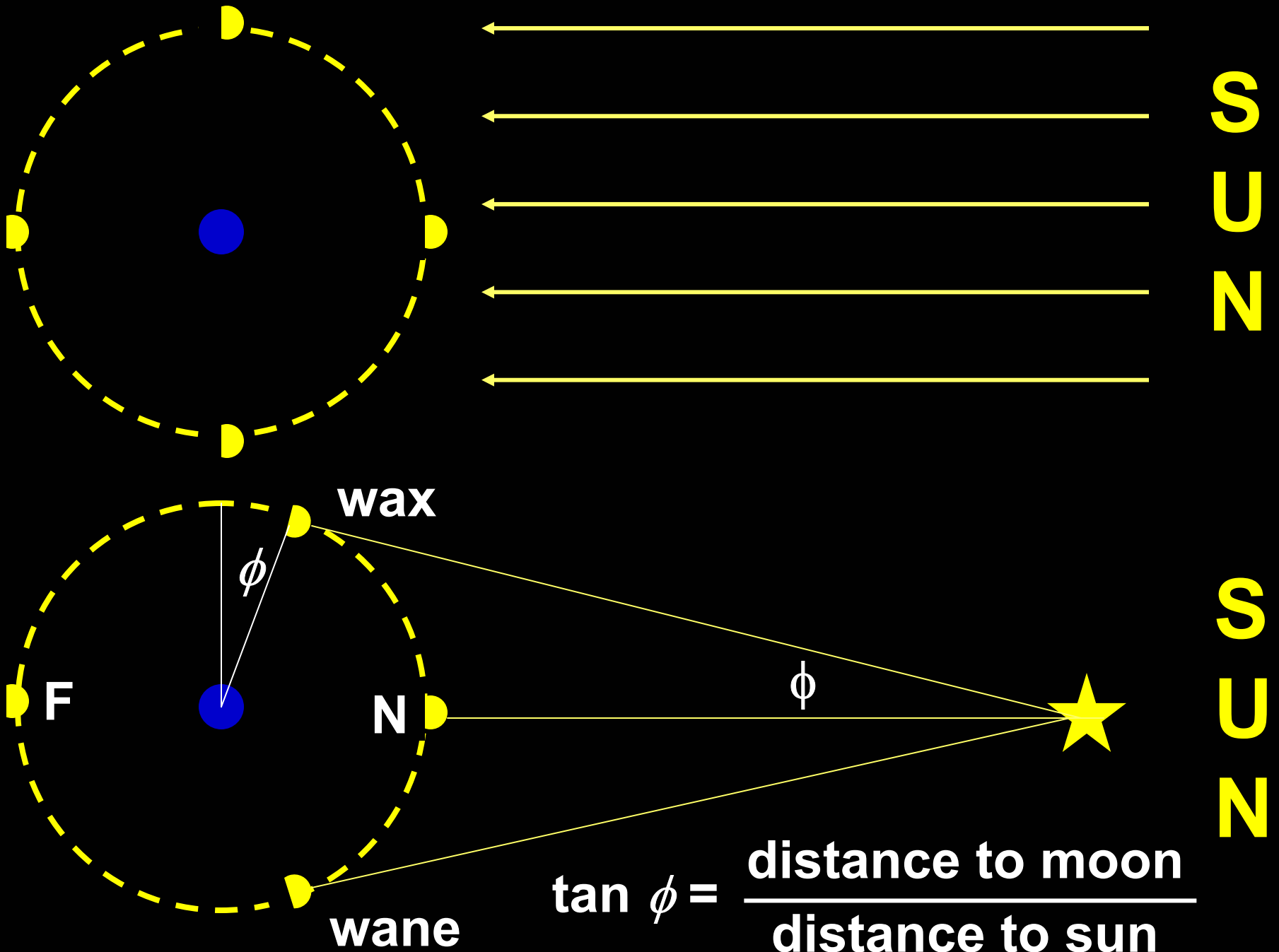


$$D = 2\pi R_{\text{EARTH}} \frac{7.2^{\circ}}{360^{\circ}}$$

R_{EARTH} = 40,000 stadia
= 6,350 km

$$\frac{\text{distance to the sun}}{\text{distance to the moon}}$$ (Aristarchus ~ 270 BC)

sun always illuminates half the moon


SUN
wax
ϕ
F
N
ϕ
SUN
wane
tan ϕ = distance to moon / distance to sun

Aristarchus said time between new moon and waxing moon was 12 hours shorter than the time between the full moon and the waning moon.*

$$\frac{\text{distance to sun}}{\text{distance to moon}} = 19$$

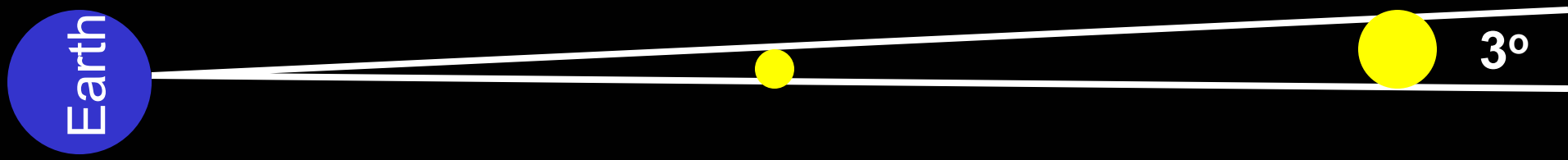
390 is correct
but geometry is perfect

*** Actual time difference is about ½ hour.**

The distance ladder

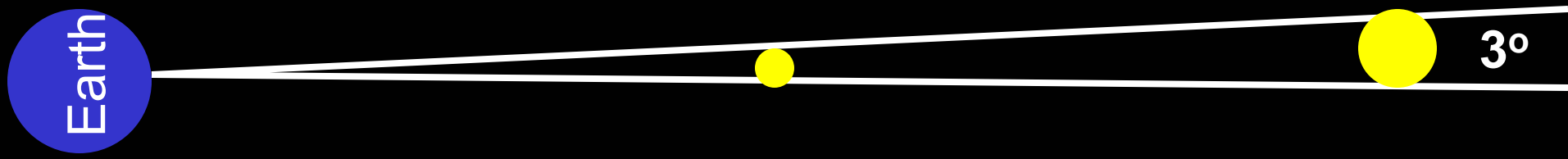
- The radius of Earth is known
- Distance to the moon in terms of Earth's radius
- Distance to the sun in terms of the distance to the moon, which in turn is known in terms of the radius of Earth
- Leads to a knowledge of the "size" of the object

- How big are things?
- How far away are things?

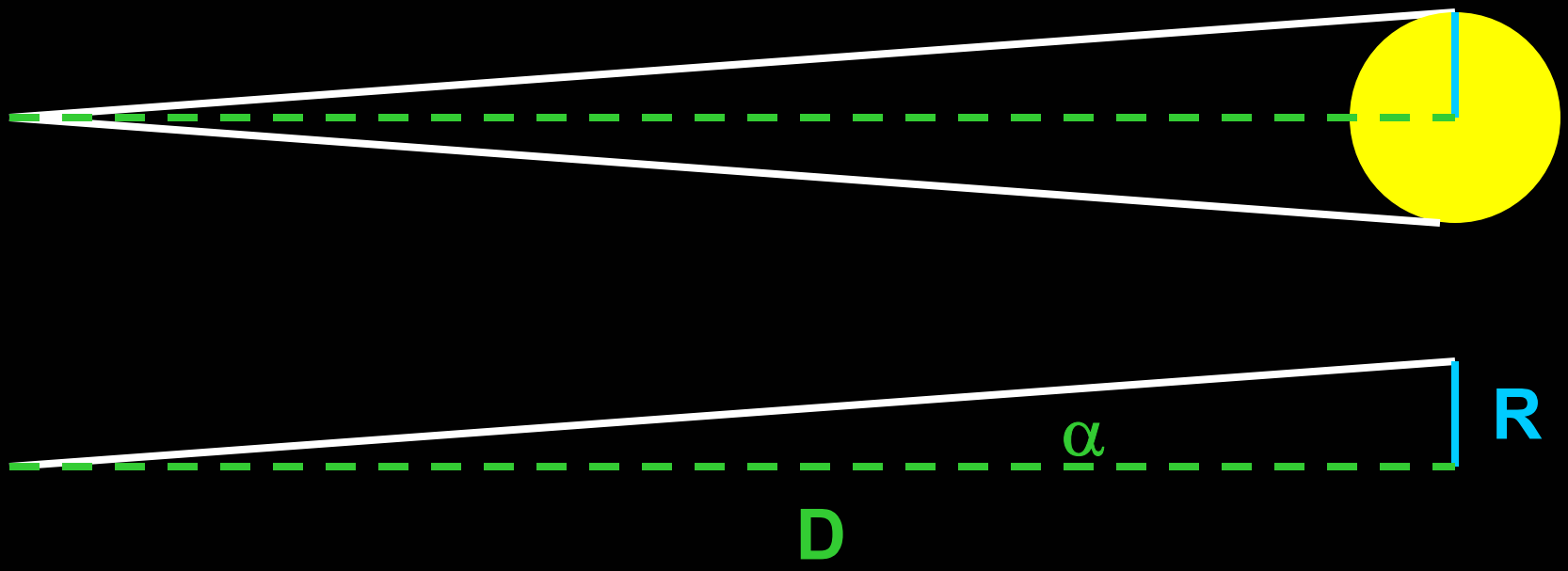


Both objects have an angular size of 3°

How far away are stars? How big are stars?

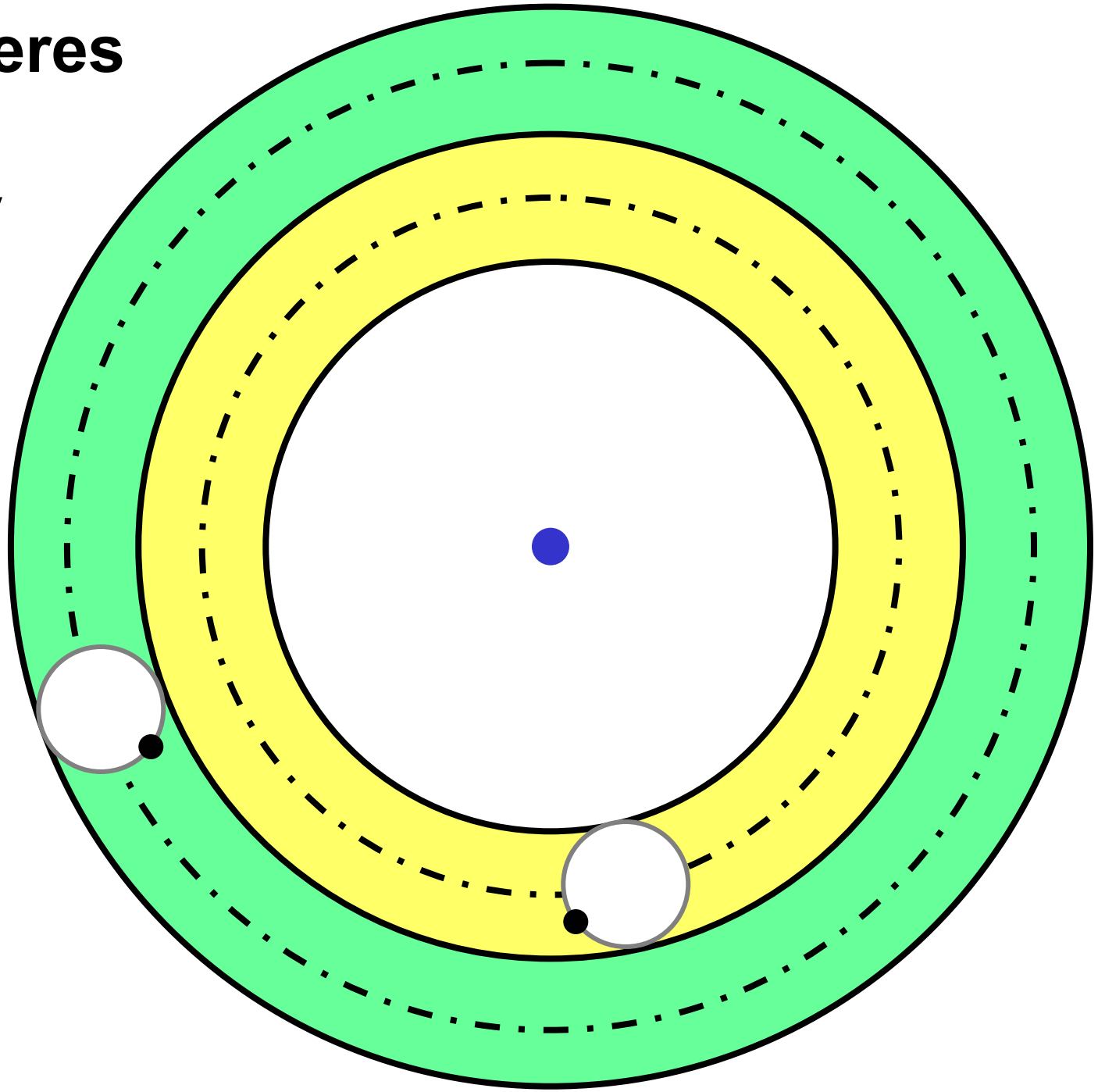


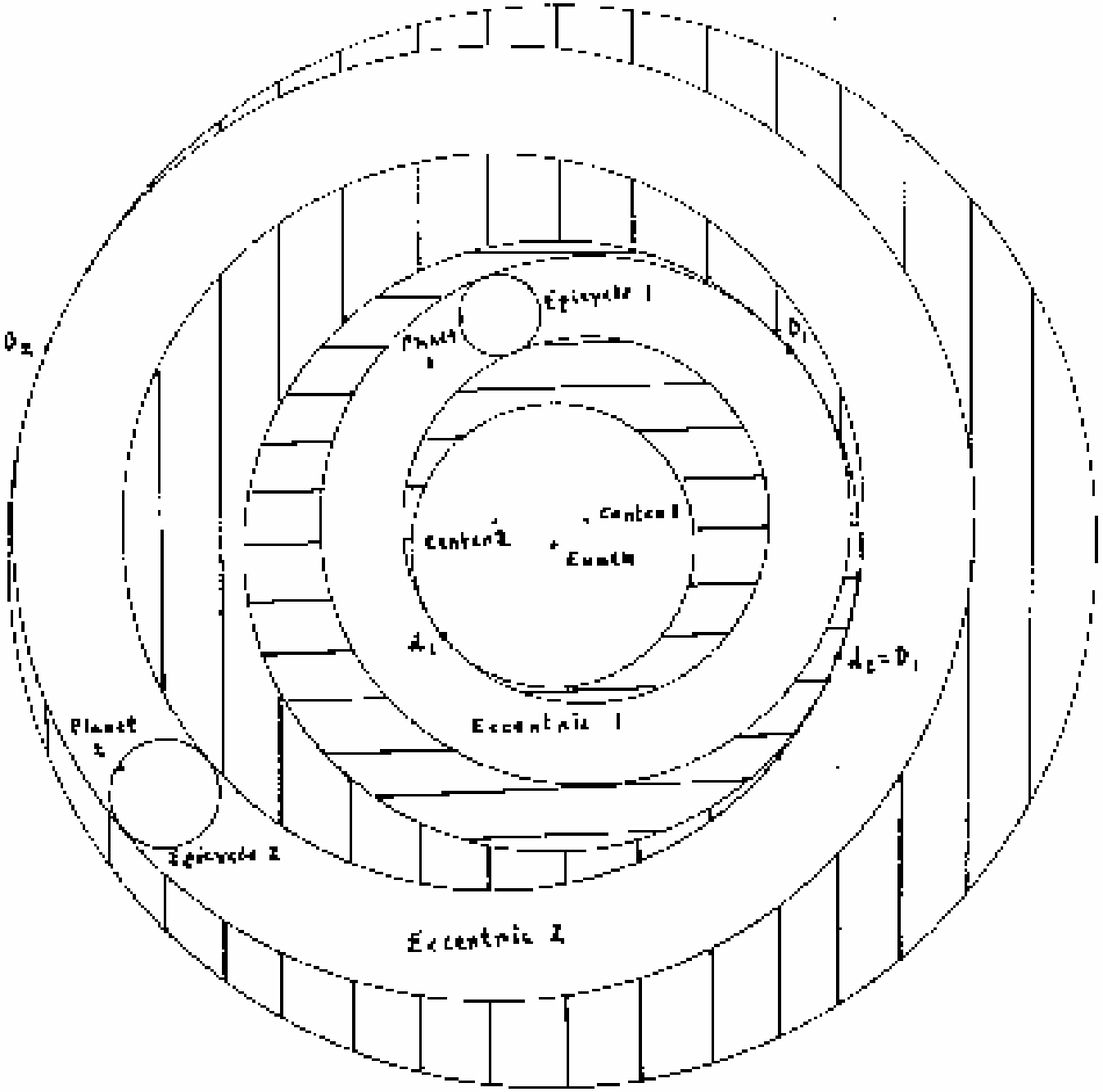
Both objects have an angular diameter of 3°



Object	Distance from Earth (in miles)		Radius (in miles)		Angular Size (in degrees)	
	Ptolemy	True	Ptolemy	True	Ptolemy	True
Earth	———	———	3,750	3,960	———	———
Moon	225,000	239,000	940	1,080	1/2	1/2
Sun	4,700,000	92,900,000	21,000	432,000	1/2	1/2

Nested Spheres of Ptolemy




Epicycle 1
Planet 1
D_2
D_1
Center 2
Center 1
Earth
d_1
$d_2 = D_1$
Eccentric 1
Planet 2
Epicycle 2
Eccentric 2

Planet	Distance from Earth (in millions of miles)		Angular Diameter (in minutes)		Actual Diameter (in miles)	
	Ptolemy	True	Ptolemy	True	Ptolemy	True
Earth	———	———	———	———	7,500	7,900
Mercury	0 .6	147	2	0.01	300	3,000
Venus	4	66	3	0.5	1,900	7,500
Mars	33	126	1.5	0.15	8,600	4,200
Jupiter	53	1,000	2.5	0.4	32,500	89,000
Saturn	74	2,000	1.7	0.2	32,000	75,000

Raphael, School of Athens, in the Stanza della Segnatura